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UPGRADE OF SYSTEMS CONTROLLING PNEUMATIC TRANSPORT OF GLASS BATCH MATERIALS

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An upgraded system for controlling pneumatic transportation of glass batch materials produced by the Stromizmeritel' JSC is considered. Comparative analysis of various schemes of control over the process of filling the pneumatic-cell pump with material is provided.

Pneumatic transport pressure systems in the production of glass batch are equipped with various modifications of pneumatic-cell pumps (PCP) with top and bottom unloading of materials. Control systems for such plants are usually based on medium-integrated microchips [1] and programmable logical matrixes [2], whose functional possibilities do not provide for modifying the control system configuration and reprogramming the PCP mode in the case of changes in such parameters as compressed air pressure in the pipeline, moisture and bulk density of material transported, the length of pneumatic pipeline and its height difference, number of pipeline branches, etc.

A common drawback of the known control system is unsteady operation of capacitance transducers supplied together with pumps, which have to monitor the prescribed level of filling the pump, especially in loading hygroscopic glass batch components or components that stick to the measuring electrode of the transducer.

The sensitivity of the level gage can be partly improved by special blowing off the measuring electrode using compressed air in the unloading mode, but this does not eliminate false signals and the level gage requires periodical mechanical cleaning as part of maintenance. Sometimes the level of the pump filling is monitored based on time, in order to maintain the functioning of the system in the case of an unsteady performance or a failure of the level transducer. In this case the charging valve of the pneumatic transport system is opened for a time estimated for filling the pump with the material to a preset level. The estimated filling time depends on the velocity of material discharge from the hopper, the charging feeder efficiency, the physicochemical properties of material, and other conditions of charging. For instance, in the case of arch formation in the supply hopper the filling of the pump may be incomplete, which decreases the efficiency and results in an excessive consumption of compressed air. Therefore, this mode of loading the PCP is recommended only for emergencies or for a replacement or a repair of the level gage.

When a pneumatic transport plant is used for alternate pumping of several materials with different bulk densities (soda, sulfate, dolomite, feldspar, etc.), the volumetric control of the PCP level employing a permanently installed discrete level gage is ineffective as well, since under equal compressed air pressure and equal length of the pneumatic pipeline the pump operates steadily under a constant mass (weight) of loaded material portions, and not their volume. In this case the process of filling the pump when changing from one component to another can be optimized by specifying different loading time.

The most efficient scheme for controlling the charge of material into a PCP is the scheme of strain-gage weighing of material proposed by V. V. Efremenkov (USSR Inventor's Certif. No. 1532476), which makes it possible to control more precisely the filling of the pump and significantly expands the functional opportunities of the pneumatic plant. Numerical parameters specified in weighing glass batch components loaded into the PCP are modified depending on the distance of material transportation and fluctuations in compressed air pressure.

In the upgraded control system for pneumatic transport of materials developed at the Stromizmeritel' JSC, the filling of the PCP can be controlled based on the level of material in the pump and the time of the loading, as well as the weight and bulk density of loaded material portions. The correction

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of the loaded portion of material based on its bulk density is needed, for instance, to exclude overfilling or insufficient filling of the pump when a consumer alternately uses "heavy" and "lightweight" soda (grades A and B according to GOST 5100–85), since a portion of grade B soda takes a 1.2 – 1.5-time larger volume than the portion of grade A soda of the equal weight.

The control panel of the upgraded PCP control system is a dust- and waterproof cabinet with an opening front panel that contains operation mode switches, manual control buttons, current and emergency indicators, and a TD-200 text display produced by Siemens (Germany) intended for setting adjustment parameters and displaying data. Inside the control cabinet there is an automatic switch, a power source, a strain-gage transducer amplifier, a CPU 24 programmable controller (Siemens) with an EM 223 input/output module for discrete signals, a contactor, a pilot relay, and safety devices and terminal blocks connected to technological sensors, the external control system, and executive mechanisms.

The position gages of the PCP executive mechanism, are VBI-type variable-induction pickups produced by the Sensor Company (Russia). The maximum and minimal compressed air pressure in the pump is controlled by the diaphragm pickups made by Camozzi (Italy) and the weight of materials is measured by the strain-gage transducer of capacity 2 tons made by CAS (South Korea), which is placed under one of the structural supports of the PCP.

If the amount of material loaded is measured based on the level of filling the PCP, a capacity transducer with a discrete output of the "current source" type with an antirattle signal delay is used.

The total number of gages and executive mechanisms involved in operation depends on the type of the PCP, the selected control modes and the system adjustment parameters that are set using the built-in text display keyboard. Depending on the system configuration, the control panel provides communication with the following executive mechanisms and gages:

– vibrator or vibration tray;
– screw feeder with motion transducer;
– loading gate and loading valve with "open" and "shut" position pickups;
– valves of pressure rise and pressure relief in the pump;
– pneumatic pipeline blow-down valve;
– discharge gate with "open" and "shut" position pickups;
– sound alarm system;
– minimum and maximum compressed air pressure pickups;
– pump filling transducer (strain-gage or variable-capacitance).

Furthermore, it is possible to communicate with the upper-level external control system via the PROFIBUS interface and with a similar control panel of another PCP, when two pumps jointly operate on the same pneumatic pipeline. The PCP control can be manual, automated, or remote.

Technical parameters of upgraded PCP control panel

Maximum quantity of input signal from PCP pickups, remote control system, and synchronization system in joint operation of PCP	13
Input circuit parameters:	
input logic type	"Current receiver"
direct current voltage, V	24
input current, mA	3 – 5
Maximum quantity of output signals controlling PCP executive mechanisms	9
Parameters of output signals controlling PCP executive mechanisms:	
voltage, V	~ 220
load current, A, not more than	1
Commuted signals in output circuits communicating with external control system (relay output):	
quantity of output signals	4
direct current voltage, V	5 – 30
load current, A, not more than	1
Quantity of programmable adjustment parameters	30
Maximum number of diagnostic messages on PCP faults	41
Power consumption (without considering power consumed by executive mechanisms), V · A, not more than	50
Operating conditions:	
supply voltage, V	~ 220 ± 22
power supply frequency, Hz	50 ± 1
ambient air temperature, °C	5 – 40
relative air humidity, %, at 30°C	Up to 85
Overall dimensions, mm	600 × 600 × 300
Weight, kg, not more than	35

The Stromizmeritel' JSC offers integrated supply of upgraded systems for controlling pneumatic transport, including the detail design and its sections: "Automatization and electric drive," "Installation and assembly of equipment," "Adjustment and start-up", as well as warranty and post-warranty maintenance. At the wish of the customer, the delivery can include:

– control panel with gages and pickups;
– PCP with top or bottom unloading of material;
– pneumatic metal pipeline that can be lined with stone casting (the lining is used to transport dolomite, sand, feldspar, and other abrasive materials);
– switch of direction of material flow inside pneumatic pipeline;
– slide gate and loading screw feeder;
– vibrator or vibration tray;
– aspiration system, etc.

The new upgraded system for controlling pneumatic transportation of glass batch components has successfully passed benchmark testing and is currently implemented at several industrial enterprises.

REFERENCES

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